

REMARKS

At the time the present the present Office Action was mailed (December 8, 2006) claims 1-28 were pending. In this response, claims 2, 15, 16 and 24 have been cancelled, claims 1, 3, 5, 6, 8-10, 18, 23, 25 and 26 have been amended, and new claim 40 has been added. Accordingly, claims 1, 3-14, 17-23, 25-28 and 40 are currently pending.

In the December 8, 2006 Office Action, all the pending claims were rejected or objected to. More specifically, the status of the application in light of the December 8 Office Action is as follows:

- (A) Claims 1-28 stand rejected under 35 U.S.C. § 112, second paragraph;
- (B) Claims 18-20 and 22 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,027,631 to Broadbent ("Broadbent");
- (C) Claims 23 and 24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Broadbent in view of U.S. Patent No. 3,652,442 to Powers et al. ("Powers");
- (D) Claims 1-3 stand rejected on six separate bases under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,466,864 to Bacon et al. ("Bacon") in combination with each of the following references: U.S. Patent No. 6,251,250 to Keigler ("Keigler"); U.S. Patent No. 6,454,918 to Sasaki ("Sasaki '918"); U.S. Patent No. 6,875,333 to Sasaki ("Sasaki '333"); Powers; U.S. Patent No. 5,516,412 to Andricacos et al. ("Andricacos"); and U.S. Patent No. 6,955,747 to Browne et al. ("Browne");
- (E) Claim 4 stands rejected on three separate bases under 35 U.S.C. § 103(a) as being unpatentable over Bacon and U.S. Published Application No. US2001/0032788 to Woodruff et al. ("Woodruff") in further combination with each of the following references: Sasaki '918, Sasaki '333, and Keigler;

(F) Claim 5 stands rejected on three separate bases under 35 U.S.C. § 103(a) as being unpatentable over: the combination of Powers, Bacon and Browne; the combination of Andricacos, Bacon, and Browne; and the combination of Browne and Bacon;

(G) Claims 6, 7 and 9 stand rejected under Section 103 as being unpatentable over U.S. Patent No. 6,214,193 to Reid et al. ("Reid") in view of Browne, and claim 8 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Reid, Browne and Woodruff;

(H) Claims 10-12 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Woodruff in view of Keigler;

(I) Claims 13-17 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Woodruff in view of Andricacos;

(J) Claim 16 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Woodruff in view of Andricacos and Bacon;

(K) Claims 26-28 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Woodruff in view of Browne;

(L) Claims 21 and 25 stand objected to as being dependent upon a rejected base claim, but were indicated to be allowable if amended to be in independent form; and

(M) The pending claims stand rejected on the basis of nonstatutory obviousness-type double patenting in light of co-pending U.S. Application No. 10,734,098 and co-pending U.S. Application No. 10,733,807.

Introduction

Aspects of the present invention are directed to improved systems for processing microfeature workpieces. One such system includes a processing vessel having a process location, and an associated support that carries a workpiece face-down at the process location. The support is movable between a load/unload position (e.g., face-up) and a process position (face-down). This arrangement facilitates processing the workpiece and moving the workpiece into and out of the vessel. A paddle device is positioned below the process plane and reciprocates along a linear path to agitate the process fluid adjacent to the process location. This arrangement replenishes the conductive solution adjacent to the workpiece to improve process efficiency. An electrode support carries a thiefing electrode in fluid communication with the process plane along a flow path that includes a virtual thief location spaced apart from the process location. This arrangement facilitates controlling the plating process at the edge of the workpiece, without allowing build-up on the thief to interfere with its operation. The foregoing features together result in a processing vessel that efficiently moves workpieces to and from the process location, and enhances the efficiency and uniformity with which the workpieces can be processed.

A. Response to the Section 112 Rejections

Claims 1-28 were rejected under 35 U.S.C. § 112, second paragraph, for including the allegedly indefinite term "at least proximate." Without commenting on or conceding the merits of this rejection, the foregoing phrase has been eliminated from the pending claims. Accordingly, the Section 112 rejections of pending claims 1, 3-14, 17-23, and 25-28 should be withdrawn.

Claim 18 was further rejected because the phrase "the electrode support" at lines 8 and 9 lacked antecedent basis. Claim 18, as amended, provides antecedent basis for the foregoing phrase. Accordingly, the additional Section 112 rejection of claim 18 should be withdrawn.

B. Response to the Section 102 Rejections of Claims 18-20 and 22

Claim 18 was rejected as being anticipated by Broadbent. Claim 18 has been amended to include features analogous to those of objected-to claim 25. More specifically, claim 18, as amended, includes a vessel configured to receive a processing fluid. The vessel has a process location with a center. An electrode support is positioned to carry at least one electrode in fluid communication with the process location, and a workpiece support is positioned to carry a microfeature workpiece at the process location. Claim 18 further includes a paddle device having at least one paddle elongated along a paddle axis and movable relative to the process location along a motion axis transverse to the paddle axis. An electric field control element is positioned along a flow path between the electrode support and the process location. The electric field control element is configured to control an electrical current density in the processing fluid at the process location to have a first value at a first circumferential site at the process location generally aligned with the motion axis, and a second value less than the first value at a second circumferential site of the process location generally aligned with the paddle axis. The first and second circumferential sites are approximately the same distance from the center of the process location. Particular embodiments of these arrangements are shown in Figures 5 and 6 of the application as filed, and discussed in the associated text.

Claim 18, as amended, is patentable over the applied references, including Broadbent, for at least the reason that none of these references discloses the combination of a field control element having the claimed features arranged in a manner that is coordinated with (a) a paddle axis along which a paddle is elongated, and (b) a motion axis along which the paddle travels. Accordingly, the Section 102 rejection of claim 18 should be withdrawn.

Claims 19, 20 and 22 depend from claim 18. Accordingly, the Section 102 rejections of these claims should be withdrawn for the foregoing reasons and for the additional features of these claims.

C. Response to the Section 103 Rejection of Claims 23 and 24

Claims 23 and 24 depend from claim 18 and were rejected as being unpatentable over Broadbent in view of Powers. While Powers discloses a paddle, Powers fails to disclose or suggest the claimed relationship between a paddle and an electric field control element. Accordingly, for at least the foregoing reasons discussed above with reference to claim 18, and for the additional features of claims 23 and 24, the Section 103 rejection of these claims should be withdrawn.

D. Response to the Section 103 Rejections of Claims 1-3

Claim 1, as amended, is directed to a system for processing microfeature workpieces, and includes a vessel configured to receive a processing fluid and having a process location positioned at a process plane to receive a microfeature workpiece. A workpiece support is positioned to carry a microfeature workpiece face down in a generally horizontal orientation at the process location during processing, and is movable relative to the vessel between a load/unload position and a process position. A paddle device is positioned below the workpiece support and has at least one paddle, with at least one of the workpiece support and the at least one paddle movable relative to the other along a linear motion path while the workpiece support carries a microfeature workpiece. The system further includes an electrode support carrying a thieving electrode in fluid communication with the process plane, with the thieving electrode positioned along a flow path that includes a virtual thief location spaced apart from the process plane.

Claim 1 was rejected separately on the basis of Browne, Andricacos, Keigler, Sasaki '918, Sasaki '333, and Powers, each in combination with Bacon. In each of these rejections, Bacon was relied on for its disclosure of a thief, and the other references were relied on for their disclosures of paddles. However, for the reasons discussed below, none of these pairs of references disclose or suggest the combination of features included in claim 1, and accordingly, the foregoing rejections should be withdrawn.

Keigler, Sasaki '918, and Sasaki '333 each disclose a rotary paddle. Accordingly, even if taken in combination with Bacon, these references fail to disclose or suggest a paddle device that is movable "along a linear motion path," as is included in claim 1. Powers and Browne each disclose wafers that are carried in a face-up orientation, on what appears to be a stationary support, with the paddle positioned above the wafer. Accordingly, the combination of either Powers or Browne with Bacon does not include a workpiece support that carries a microfeature workpiece "face-down in a generally horizontal orientation," a paddle device "positioned below the workpiece support," or a workpiece support "movable relative to the vessel between a load/unload position and a process position." In fact, Browne teaches away from a workpiece support that carries a microfeature workpiece in a face-down orientation with a paddle device positioned below the workpiece support by reciting the advantages of a face-up orientation in which bubbles are "buoyancy driven upwardly" (Browne at column 1, lines 53-58).

Andricacos discloses a wafer that is supported in a vertical orientation, and a paddle that is positioned vertically alongside the wafer. Accordingly, Andricacos fails to disclose or suggest a workpiece support carrying a microfeature workpiece "face-down in a generally horizontal orientation," and a paddle device "positioned below the workpiece support." Andricacos in fact teaches away from workpiece orientations other than vertical orientations, stating that "[a] significant advantage of the inner cell 12 and its orientation in space allows for "the vertical orientation of both the article 14 in the rack 18, and the anode 22 which provides not only for uniform electroplating of the article 14 in its vertical orientation, but allows relatively easy installation and removal of the rack 18 with the article 14 thereon" (Andricacos at column 4, lines 1-8). Furthermore, none of the foregoing references discloses a thieving electrode that is "positioned along a flow path that includes a virtual thief location spaced apart from the process plane." Accordingly, for at least the foregoing reasons and for the additional features of claim 1, the outstanding Section 103 rejections of claim 1 should be withdrawn.

Claim 2 has been cancelled and accordingly, the Section 103 rejection of claim 2 is now moot. Claim 3 depends from claim 1. Accordingly, the Section 103 rejection of claim 3 should be withdrawn for the foregoing reasons and for the additional features of this claim.

E. Response to the Section 103 Rejection of Claim 4

Claim 4 depends from claim 1 and was rejected under Section 103 on three separate grounds: Keigler in view of Bacon and Woodruff; Sasaki '918 in view of Bacon and Woodruff; and Sasaki '333 in view of Bacon and Woodruff. Claim 4 includes, in addition to the features of claim 1, an electrode support having a plurality of electrode chambers at least partially separated from each other by dielectric barriers, with gaps between the dielectric barriers forming a corresponding plurality of virtual electrode locations spaced apart from the process location.

Woodruff discloses an electrochemical processing chamber that includes walls defining a plurality of electrode compartments, each having at least one electrode, and a virtual electrode unit defining a plurality of flow conduits, at least one of which is in fluid communication with each of the electrode compartments. In rejecting claim 4, the Examiner alleges that it would have been obvious to one of ordinary skill in the art to have added the dielectric walls disclosed by Woodruff to the system formed by the combination of either Keigler, Sasaki '918, or Sasaki '333 with Bacon. For at least the following reasons, applicants respectfully disagree.

Each of the foregoing references discloses an arrangement for improving the uniformity with which a conductive layer is applied to a substrate, and touts the advantages of the disclosed arrangement. Accordingly, neither the references themselves nor the general knowledge available to one of ordinary skill in the relevant art would suggest adding further features (e.g., multiple electrode chambers forming a corresponding plurality of virtual electrode locations) to a system that is already described as achieving the

desired improved uniformity. For example, Keigler discloses that "the use of reciprocating rotational motion in the present invention to mix the plating solution in the chamber, as distinguished from continuous rotational fluid motion that, as earlier stated, causes fluid particles to travel in circles known as Coriolis motion, breaks up this pattern and causes thorough and uniform mixing throughout all parts of the chamber and along the workpiece surface" (Keigler at column 8, lines 10-16). Keigler further states that his arrangement "provide[s] very good field uniformity for maximum plated film macro-scale uniformity" and that his invention "provides novel independent control of electric field uniformity and fluid agitation at the workpiece surface" (Keigler at column 8, lines 54-62). Based on Keigler's already-achieved uniformity, no suggestion exists for modifying his device to include "a plurality of electrode chambers" with dielectric barriers having gaps "forming a corresponding plurality at virtual electrode locations spaced apart from the process location."

Sasaki '918 states that, with his disclosed arrangement of openings provided in a division wall, "uneven plating will be further avoided, since not only uniform current density becomes easily obtainable, but also variation of current density at every part becomes easily calculable, and as a result optional variation of current density at every part becomes easily effected" (Sasaki '918 at column 3, lines 56-61). Sasaki '333 discloses a rotational stirrer that also oscillates and "performs a more complicated motion compared to a case where the stirrer is rotated" (Sasaki '333 at column 3, lines 17-20). This arrangements "suppress[es] the occurrence of an eddy flow" and "enables the whole area of a target plating surface of a wafer to be subjected to more uniform plating treatment and moreover enables a target plating surface of a wider area to be subjected to positive and uniform plating treatment" (Sasaki '333 at column 3, lines 26-31). Sasaki '333 further states that "if the whole area within the plating tank can be stirred, it is possible to more positively ensure the supply of plating ions and a uniform condition of the current density distribution" (column 5, lines 54-57). Sasaki '333 still further states that "the whole region of the plating solution corresponding to the target plating surface Ws is uniformly stirred by

the stirrer 40 and it becomes possible to perform uniform plating treatment of the whole target plating surface Ws" (Sasaki at column 9, lines 35-39).

Based on the disclosures of Keigler, Sasaki '918 and Sasaki '333, there is no suggestion either on the references themselves or on the art generally that further modifications would further enhance uniformity, nor that such modifications are necessary or beneficial in light of the already-achieved uniformity. Accordingly, it would not be obvious to add the second electrode disclosed by Bacon to the disclosed systems, nor to add "a plurality of electrode chambers" with dielectric barriers having gaps "forming a corresponding plurality at virtual electrode locations spaced apart from the process location." For at least the foregoing reasons, there exists no suggestion to combine the features disclosed on the prior art in the manner identified by claim 4. Therefore, the Section 103 rejections of claim 4 should be withdrawn.

F. Response to the Section 103 Rejection of Claim 5

Claim 5 was rejected as being unpatentable over Powers in view of Bacon and Browne. Claim 5 depends from claim 1 and includes, in addition to the features of claim 1, an at least partially enclosed paddle chamber positioned between the electrode support and the process location that houses the paddles. Powers, Bacon, and Browne were discussed above, and, as discussed above, these references taken together fail to disclose or suggest the features of claim 1 and therefore the features of claim 5. Accordingly, the Section 103 rejection of claim 5 should be withdrawn for at least the foregoing reasons and for the additional features of this claim.

Claim 5 was also rejected as being unpatentable over the combination of Andricacos with Bacon and Browne, and the combination of Browne and Bacon. For at least the foregoing reasons discussed above with reference to claim 1, and for the additional features of claim 5, these additional rejections of claim 5 under Section 103 should also be withdrawn.

G. Response to the Section 103 Rejections of Claims 6-9

Claims 6, 7 and 9 were rejected under Section 103 as being unpatentable over Reid in view of Browne. Claim 8 was rejected under Section 103 as being unpatentable over Reid in view of Browne and further in view of Woodruff. Claims 6-9 have been amended to depend from claim 1. Reid discloses an arrangement of spray nozzles in a plating cell. However, Reid fails to cure the deficiencies described above with reference to the Section 103 rejections of claim 1. Accordingly, the Section 103 rejections of claims 6-9 should be withdrawn for the foregoing reasons and for the additional features of these dependent claims.

H. Response to the Section 103 Rejections of Claims 10-12

Claim 10, as amended, is directed to a system for processing microfeature workpieces that includes a vessel, workpiece support, and paddle device generally similar to the corresponding elements of claim 1. Claim 10, as originally filed, further includes an electrode support having features generally similar to those described above with reference to claim 4, including a plurality of electrode chambers separated from each other by barriers, with gaps between the barriers forming a corresponding plurality of virtual electrode locations spaced apart from the process plane.

The Office Action alleges that it would have been obvious to one of ordinary skill in the art to have added the paddle device taught by Keigler to the apparatus of Woodruff. However, as discussed above with reference to claim 1, Keigler discloses a paddle that moves along a rotary motion path, while claim 10 includes a linear motion path between a workpiece support and a paddle. Accordingly, Woodruff and Keigler taken together fail to disclose or suggest all of the features of claim 10.

As discussed above, other references applied by the Examiner to claims other than claim 10 disclose linearly-translating paddles. However, it would not have been obvious to one of ordinary skill in the art to combine such paddles with Woodruff's apparatus. For

example, Woodruff discloses interchangeable virtual electrode units and field shaping units to uniformly plate different types of workpieces. The uniform plating characteristics can be provided to different workpieces even though the seed layers applied to the workpieces vary. Other benefits include achieving plating to specific film profiles across a workpiece (e.g., concave, convex, flat) (Woodruff at paragraph 73). With this range of flexibility in addressing plating uniformity, and/or specific plating profile characteristics, there is no suggestion to further add flow agitation. Accordingly, the Section 103 rejection of claim 10 should be withdrawn.

Claims 11 and 12 depend from claim 10 and accordingly, the Section 103 rejections of these claims should be withdrawn for at least the foregoing reasons and for the additional features of these dependent claims.

I. Response to the Section 103 Rejections of Claims 13-17

Claim 13 has been amended to depend from claim 1 and includes, in addition to the features of claim 1, a magnet positioned to impose a magnetic field at the process location to orient material deposited on a microfeature workpiece. Claim 13 further clarifies that the electrode support is movable relative to the vessel between a process position and a removed position along a motion path that does not pass through the process plane.

Claim 13 stands rejected under Section 103 on the basis of Woodruff and Andricacos. The Examiner also considered claim 13 rejectable under Section 103 over Woodruff in combination with either Browne or Powers. Andricacos, Browne and Powers were discussed above with reference to claim 1 (from which claim 13 depends) and, as discussed above, these references teach away from the features of claim 1, including a workpiece support that carries a microfeature workpiece "face-down in a generally horizontal orientation." Woodruff discloses a system in which the workpiece is carried in a face-down orientation. However, in light of the clear contrary teachings of Andricacos, Browne and Powers, there is no suggestion to apply specific features of their disclosed

systems to Woodruff's system in a way that that directly controverts the stated advantages of their workpiece orientations (e.g., vertical in the case of Andricacos, and face-up in the case of Browne and Powers). Accordingly, for at least the foregoing reasons and for the additional features of claim 13, the Section 103 rejection of claim 13 should be withdrawn.

Claims 15 and 16 have been cancelled and accordingly, the Section 103 rejections of these claims are now moot. Claims 14 and 17 depend from claim 13. Accordingly, the Section 103 rejections of these claims should be withdrawn for the foregoing reasons and for the additional features of these dependent claims.

J. Response to the Section 103 Rejection of Claim 16

Claim 16 depends from claim 13. Accordingly, the Section 103 rejection of claim 16 on the basis of Woodruff in view of Andricacos and Bacon should be withdrawn for the foregoing reasons and for the additional features of this dependent claim.

K. Response to the Section 103 Rejection of Claims 26-28

Claim 26 is directed to a microfeature workpiece processing system that includes a vessel having a process location, and a workpiece support that is positioned to carry a microfeature workpiece face-down in a generally horizontal orientation at the process location, and that is positioned to rotate the microfeature workpiece relative to the vessel. The workpiece support is movable relative to the vessel between a load/unload position and a process position. The system further includes a paddle device positioned below the workpiece support and having at least one paddle, wherein at least one of the at least one paddle and the workpiece support is movable relative to the other along a generally linear motion path while the workpiece support carries a microfeature workpiece.

Claims 26-28 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Woodruff in view of Browne. As discussed above with reference to claim 4, neither Woodruff nor the general knowledge of one of ordinary skill in the relevant art would

suggest that a paddle should be added to Woodruff's disclosed system for at least the reason that Woodruff's disclosed system is described as already producing uniform and/or controlled plating profiles. Furthermore, as discussed above with reference to claims 1 and 13, Browne explicitly recites the advantages of carrying a workpiece in a face-up orientation. Browne provides no suggestion to extract individual features of his system (e.g., a paddle positioned above a workpiece support) and apply them in a way that controverts his stated advantages. More specifically, Browne provides no suggestion to move his paddle, which is positioned above his workpiece, to be "below the workpiece support," in light of his stated advantages of doing just the opposite. Accordingly, the Section 103 rejection of claim 26 should be withdrawn.

Claims 27 and 28 depend from claim 26 and accordingly, the Section 103 rejections of these claims should be withdrawn for the foregoing reasons and for the additional features of these dependent claims.

L. Indication of Allowable Subject Matter

Claims 21 and 25 were each indicated to be allowable if rewritten to be in independent form. Claim 21 has been rewritten in independent form as claim 40. Accordingly, claim 40 is now in condition of allowance.

M. Response to the Double Patenting Rejections

Claims 1-28 were rejected on the grounds of nonstatutory obviousness-type double patenting in light of co-pending Application Nos. 10,734,098 and 10,733,807. Without commenting on or conceding the merits of the double patenting rejections, and in an effort to expedite prosecution of the present application, applicants enclose two Terminal Disclaimers, each referencing one of the two pending applications identified above. In light of the Terminal Disclaimers, the double patenting rejections of the currently pending claims should be withdrawn.

N. Consideration of IDS

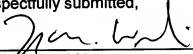
Applicants wish to draw the Examiner's attention to the accompanying Information Disclosure Statement and associated Declaration of Thomas L. Ritzdorf. In light of both, applicants wish to have U.S. Patent Application Publication No. US2005/0167275A1 considered as admitted prior art to the present application.

O. Conclusion

In view of the above amendment, applicant believes the pending application is in condition for allowance. If the Examiner becomes aware of any informalities or other issues that may be expediently handled by telephone, he is encouraged to contact the undersigned attorney at (206) 359-3257.

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Respectfully submitted,

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